SOME NEW MODIFICATIONS OF OLD EXPERIMENTS IN PHYSICS [1]

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I. HOW TO OBTAIN THE BEST RESULTS FROM A TUNING FORK WHICH VIBRATES SYMPATHETICALLY WITH ANOTHER

The tuning forks are first brought into unison by sliding a piece of soft rubber tubing, about half an inch long, up or down one prong of one of the forks. The open ends of the resonators are then placed a short distance apart and each resonator is placed upon two pieces of new soft rubber tubing. If the experiment is tried first without the soft rubber tubing supports and then with them the intensity of the effect is easily seen to be several times as great in the latter case. By this method the author made audible over a large room a tuning fork of the cheapest grade used in the laboratory. For those whose hearing is somewhat impaired vibrations of the second fork may be made visible by suspending an elastic ball about a quarter of an inch in diameter with a thread four or five inches long so that it just touches the prong of the second fork. The fork in this case made the pendulum in contact with it vibrate through an amplitude of at least half an inch, which could be easily seen in all parts of the room. The function of the soft rubber tubing is to conserve the energy of the forks in themselves, thus preventing the dissipation of energy to the table which results when they rest directly upon the table.

II. A DEMONSTRATION EXPERIMENT ON ABSORPTION

Using sunlight or parallel rays from a projection lantern and a single slit of the optical disc, first place a piece of heavy plate glass, silvered on the back, in the path of the rays and

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obtain the multiple reflections of the beam upon the disc, as in Fig. 1. Then replace the piece of silvered plate glass with

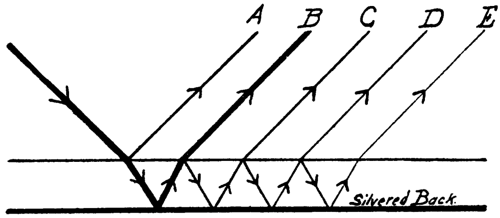

Fig. 1.

one which has been covered on the back with a mixture of lampblack and banana oil. In the second case the only reflection obtained is at the first surface, the beam which passes into the glass being so completely absorbed when it reaches the blackened surface that multiple reflection does not take place (see Fig. 2).

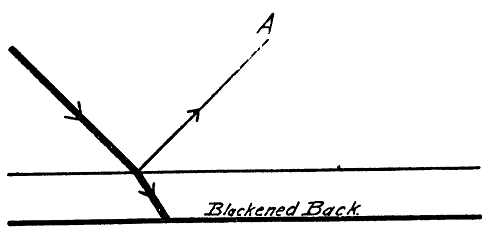

Fig. 2.

The experiment also shows that when reflection takes place from a mirror most of the light is reflected by the silvered surface, for the beam B from the back of the mirror is much more intense than the beam A or any of the multiple reflections following B.

III. A CONVENIENT METHOD OF PROJECTION

Place the electroscope or whatever is to be projected upon the screen immediately in front of the objective of the projection lantern, thus using the whole lantern as a condenser. Then place a convex lens in front of the object and move it toward the screen until the object is distinctly focused on the screen, the object and screen then being at conjugate foci. The proper

focal length of the lens will depend on the magnification desired and the distance to the screen. For most purposes a lens of focal length between twenty and thirty centimeters will be found suitable.

A glass tank of any dimensions may be placed in front of the lantern and used to contain the elements of a voltaic cell, and when the electrodes are focused on the screen it makes a very convenient method of showing such phenomena as effect of amalgamating zinc plates, formation of hydrogen at the positive electrode, etc.

The method is convenient for projecting many other experiments upon the screen.

IV. A MODIFICATION OF AN EXPERIMENT ON AIR PRESSURE

Take two glass constant-weight hydrometer tubes, fifty or sixty centimeters long, such as are used in Millikan and Gale's laboratory course, the two tubes being of the proper diameter so that one slides easily into the other. Fill the larger one with water, push the smaller one part way down into it, invert both, and the pressure of the air will force the smaller tube completely into the larger one when the whole is supported by holding the larger one in the hand or a clamp.

If the tubes fit very closely the action will take place more rapidly when gasoline is used in place of water, as the gasoline runs out between the tubes more easily.

V. A MODIFICATION OF THE CARTESIAN DIVER, OR A FAKE LUNG TESTER

Invert a small pill bottle partly filled with air (but not sufficiently to float) in a flat bottle filled with water. With the aid of a finely drawn out tube with a J on the lower end and a rubber from a pen filler on the top, force fine bubbles of air into the pill bottle until it just rises to the surface. It will then be very delicately balanced so that a small increase in pressure will cause the diver to descend. Then cork the bottle with a rubber stopper into which is inserted part way a glass tube. Attach a piece of rubber tubing to the glass tube to blow upon.

The pressure which causes the diver to descend is obtained by pressing upon the sides of the bottle. This can be done unobserved by blowing on the tube while the bottle is held in the hands. The apparatus is then given to a friend or member of the class who attempts to blow the diver down but of course fails.

If a slight pressure on the sides of the bottle fails to cause the diver to descend, force the stopper into the bottle a little with a rotary motion until the diver just starts down, and then the added pressure necessary to send it down may easily be obtained by pressing the sides of the bottle between the thumb and finger.

An outfit looking exactly like the one just described may be made to accompany it, the only difference being that the glass tube runs completely through the stopper instead of part way. This diver can then be forced down by blowing on the tube, but not by pressing on the bottle, the reverse of the other one.

The diver in the first outfit may be so delicately balanced that when forced down by pressure from the sides of the bottle it will stay at the bottom due to the pressure of the liquid above. It may then be caused to ascend by pressing lightly on the edges of the bottle, thus relieving some of the pressure due to its being corked tightly. It is very interesting to see how even a heavy flat bottle will thus have its volume diminished by a slight pressure on the flat sides and increased by a slight pressure on the edges.

VI. A LABORATORY METHOD FOR DETERMINING THE INDEX OF REFRACTION

Take a rectangular battery jar about twenty or twenty-five centimeters deep. Fasten a piece of fine white thermometer tubing, *T*, across the middle of the bottom, and paste a paper scale on the outside of the jar so that its zero end is even with the upper edge of the thermometer tubing. (See Fig. 3.) With the aid of another piece of the same kind of tubing held just outside the jar, locate by the method of parallax the image

T' of the tube in the bottom of the jar. The reading at the top of the tube outside subtracted from the depth of the water will then give the distance of the image below the surface. Call this distance i. Call the distance from the top of the tubing in the jar to the surface of water o. This is read off directly on the scale. Then the index of refraction $n=o/i$.

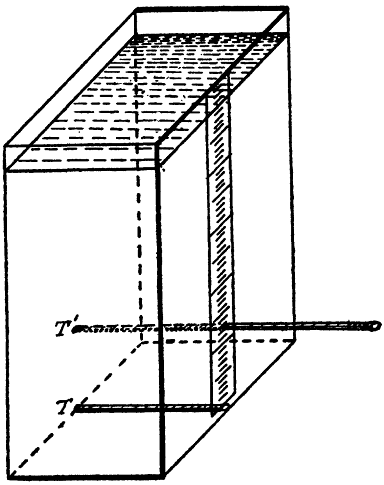

Fig. 3.

The following values for the index of refraction of water were obtained from ten successive independent observations: 1.351; 1.338; 1.333; 1.338; 1.327; 1.346; 1.332; 1.339; 1.341; 1.323. Mean value of $n=1.337$.

This experiment was suggested from the theory underlying it as found in Millikan and Gale's *First Course in Physics*, p. 411.